QH
1
N314X
NH

ISSN 0096-4158

The Maryland Naturalist

Volume 47, Number 1 Summer 2005

Contents

Bat emergence and swarming surveys at 4 western Maryland caves 1
Joshua B. Johnson and J. Edward Gates

The Dytiscidae and Hydrophilidae (Insecta: Coleoptera) of Eastern Neck National Wildlife Refuge, Maryland 14
C. L. Staines and S. L. Staines

First Records of the Rock Vole (*Microtus chrotorrhinus*) in Maryland 21
Walter Bulmer, Ralph P. Eckerlin, and Ed Thompson

Instructions to Authors 25

SMITHSONIAN
JAN 05 2007
LIBRARIES

Founded in 1929

A Biannual Publication of the Natural History Society of Maryland

NOV 22 2006

The Maryland Naturalist

A Biannual Publication of the Natural History Society of Maryland

Managing Editor
Joel W. Snodgrass
The Maryland Naturalist
Department of Biological Sciences
Towson University
Towson, MD 21252, USA

The Maryland Naturalist is a peer-reviewed, biannual publication of the Natural History Society of Maryland, Inc., a 501(c)(3) scientific and educational non-profit organization. Funding for publication is provided by membership dues. Membership in the Society is open to all individuals or institutions interested in natural history. Dues are paid annually and are as follows: individual - $25.00; family - $35.00; contributing - $65.00; sustaining - $120.00; life - $750.00; institutional - $50.00. Contact information can be found at the bottom of this page.

The Maryland Naturalist seeks to publish original research concerning the natural history and ecology of Maryland and adjacent states. Full-length manuscripts may deal with subject matter including the geology, chemistry, and biology of the Maryland region. Short communications should describe unusual observations. Instructions for preparation of manuscripts can be found in the in the first issue of each year.

Board of Trustees

Chairman of the Board: Charles A. Davis

Patricia Cornman
Ralph Eshelman
Timothy Eldredge Hoen
Joseph McSharry
Mark Tegges

Officers for 2004 and 2006

President: Joseph McSharry
Secretary: Patricia Cornman
Treasurer: Timothy Eldredge Hoen

Published by the Natural History Society of Maryland, Inc.
2643 North Charles Street
Baltimore, MD 21218, USA
410-235-6116
www.marylandnature.org

Printed by Cadmus Journal Services
Linthicum, MD 21090, USA

Bat emergence and swarming surveys at 4 western Maryland caves

Joshua B. Johnson[1] and J. Edward Gates

Appalachian Laboratory, University of Maryland Center for Environmental Science (UMCES), 301 Braddock Road, Frostburg, Maryland 21532

Abstract.—Caves are an important habitat component for many bat species as breeding sites during spring and fall and roost sites during all seasons, especially winter. Historically in western Maryland, few caves have been used by endangered Indiana myotis (*Myotis sodalis*) and rare eastern small-footed myotis (*M. leibii*). We conducted bat surveys at 4 caves in western Maryland during spring emergence 2004 and 2005, and fall swarming 2004 to determine overall bat activity and presence of endangered and rare bats. We captured 1,236 bats including 19 big brown bats (*Eptesicus fuscus*), 3 eastern small-footed myotis, 470 little brown myotis (*M. lucifugus*), 575 northern myotis (*M. septentrionalis*), and 169 eastern pipistrelles (*Pipistrellus subflavus*). We observed 1 eastern small-footed myotis roosting at night at Crabtree Mine. Greises Cave consistently had higher bat activity than all other surveyed caves combined. Our survey results are consistent with previous research and indicate that eastern small-footed myotis hibernate in some western Maryland caves, but are relatively rare compared to other cavernicolous bat species. It is unlikely that there are significant numbers of hibernating Indiana myotis in these caves based on our survey data and historic records.

Introduction

Caves serve numerous important functions for bats. Some bat species hibernate in caves to conserve energy during winter when food resources (i.e., insects) are low (Barbour and Davis 1969). Most caves likely have their highest bat occupancy in winter (Gates et al. 1984). During spring, bats emerge from hibernation, varying in exit times and patterns (Cope and Humphrey 1977; Gates et al. 1984). Relatively few bats in eastern North America roost in caves during summer months (June–August) and those that do commonly are males (Hall and Brenner 1968; Johnson et al. 2003). Female bats, with the exception of Virginia big-eared bats (*Corynorhinus townsendii virginianus*) and gray myotis (*Myotis grisescens*), typically do not use caves as summer maternity roost sites (Barbour and Davis 1969). In late summer and early fall, bats arrive at cave entrances and exhibit a swarming behavior that is thought to fulfill life history aspects, such as mate selection, breeding, and hibernacula selection (Fenton 1969; Cope and Humphrey 1977; Schowalter 1980).

In Maryland, 10 bat species have been documented, including big brown bats (*Eptesicus fuscus*), silver-haired bats (*Lasionycteris noctivagans*), eastern red bats (*Lasiurus borealis*), hoary bats (*L. cinereus*), eastern small-footed myotis (*Myotis leibii*), little brown myotis (*M. lucifugus*), northern myotis (*M. septentrionalis*), Indiana myotis (*M. sodalis*), evening bats (*Nycticeius humeralis*), and eastern pipistrelles (*Pipistrellus subflavus*; Paradiso 1969). Of these, big brown bats, eastern

[1]jjohnson@al.umces.edu

small-footed myotis, little brown myotis, northern myotis, Indiana myotis, and eastern pipistrelles are most likely to use caves, and have been documented at Maryland caves at various times of the year (Gates et al. 1984; Griffith and Gates 1985; Raesly and Gates 1987; Marsh 1998). Although it is unclear if endangered Indiana myotis have been documented using western Maryland caves as hibernacula, past fall swarming surveys have resulted in few Indiana myotis captures. Moreover, Indiana myotis have been documented at only a few Maryland caves (Crabtree Cave, Crabtree Mine, Greises Cave, John Friend Cave, and Round Top Mines). Eastern small-footed myotis are rarely encountered during hibernacula surveys in western Maryland and relatively few have been captured during spring and fall swarming surveys compared to more common species, including little brown myotis, northern myotis, and eastern pipistrelles (Gates et al. 1984; Raesly and Gates 1987; Marsh 1998; D. Feller, Maryland Department of Natural Resources, personal communication). However, eastern small-footed myotis have been documented at 10 Maryland caves, mines, and tunnels (Gates et al. 1984, Marsh 1998, D. Feller, Maryland Department of Natural Resources, personal communication). Although major hibernacula in Maryland are surveyed regularly by the Maryland Department of Natural Resources, spring emergence and fall swarming surveys have not been conducted at several historically important caves since the mid-1990s. Our objective was to document bat activity at caves in western Maryland during spring emergence and fall swarming.

Study Area and Methods

We conducted bat surveys at caves in western Maryland including Crabtree Cave, Greises Cave, John Friend Cave, and Round Top Mine No. 4. These caves historically have been used by Indiana myotis and eastern small-footed myotis and represent 2.7% of Maryland's known caves. The karst geology predominately found in Allegany, Garrett, and Washington counties contains 89% of Maryland's known caves (Franz and Slifer 1976). Crabtree Cave and John Friend Cave are in the Appalachian Plateau physiographic province in Garrett County. Crabtree Cave is the largest cave in Maryland and contains >1,280 m of passage. Its entrance is 0.7 × 1.0 m and protected by a large angle-iron gate. John Friend Cave has >400 m of passage. Its entrance is in a small sink, approximately 3.5 m deep and 5 m in diameter, which leads to the gated horizontal entrance, approximately 1.5 × 2.5 m. Greises Cave is in the Ridge and Valley physiographic province in Allegany County and contains >75 m of passage. A small slope leads to the 2.4 × 3.0 m horizontal entrance, which is unprotected. Round Top Mine No. 4 is in the Ridge and Valley physiographic province in Washington County. It is a natural limestone cave that was enlarged by mining during the 1800s and early 1900s and contains >150 m of passage (Franz and Slifer 1976). An angle iron gate protects the 2.0 × 5.0 m entrance.

We surveyed bats at Crabtree Cave, Greises Cave, and John Friend Cave during spring 2004 and 2005, and fall 2004. Due to logistical constraints, we surveyed bats only once at Round Top Mine No. 4 in fall 2004. We placed a harp trap (1 × 1 m; Bat Conservation and Management, Carlisle, Pennsylvania) in or adjacent to cave entrances to capture bats entering or exiting the caves. The harp trap was completely surrounded with tarpaulin to prevent bats from bypassing the trap. Caves were trapped

between sunset and 0000 hours. We released captured bats immediately after recording species (Menzel et al. 2002), sex, reproductive condition (Racey 1988), weight and forearm length. Bat recaptures at caves or mines during fall swarming typically are <5% (Fenton 1969; Marsh 1998).

Results

During spring (mid-April–early-May) 2004 and 2005, we surveyed bats at Crabtree Cave, John Friend Cave, and Greises Cave 3 times per year (18 nights total). During fall (mid-September–late-October) 2004, we surveyed bats at each cave 3 times (9 nights total) with the exception of Round Top Mine No. 4, which we surveyed once in August 2004. We surveyed bats for a total of 126 hours among the 4 caves (Table 1). We captured 1,236 bats including big brown bats (n = 19) at 1 cave, eastern small-footed myotis (n = 3) at 2 caves, little brown myotis (n = 470) at 4 caves, northern myotis (n = 575) at 4 caves, and eastern pipistrelles (n = 169) at 4 caves (Table 2). Greises Cave consistently produced more bats per hour than any other cave (Table 1) and more bat captures than all other caves combined (Table 2). During spring at Greises Cave, we captured more northern myotis than eastern pipistrelles or little brown myotis. During fall, little brown myotis were the most commonly captured species at Greises Cave. We captured no rare or endangered bats at Greises Cave. At John Friend Cave, overall captures of little brown myotis, northern myotis, and eastern pipistrelles were similar in fall. However, northern myotis were the most commonly captured species during spring. We captured a male eastern small-footed myotis at John Friend Cave on 22 Sept 2004. At Crabtree Cave, the most commonly captured bat species during all survey periods was northern myotis. We captured a female eastern small-footed myotis at Crabtree Cave on 18 Apr 2004 and 5 Apr 2005. Round Top Mine No. 4 was the only cave where we captured big brown bats. No rare or endangered bats were captured at Round Top Mine No. 4.

Sex ratios were more consistently male-biased during fall swarming than during spring emergence (Table 3). Overall, the male:female sex ratio during fall was 2.24:1.00 and 0.95:1.00 during spring. This seasonal sex bias was characteristic of all species except northern myotis, which was male-biased during spring (1.89:1.00).

Discussion

Bat capture rates during this study typically were higher than in previous western Maryland bat surveys by Gates et al. (1984) and Marsh (1998). We captured 9.8 bats per hour overall. Marsh (1998) captured 3.2 and 3.4 bats per hour in 1995 and 1996, respectively. Gates et al. (1984) captured 6.3 bats per hour overall. It is difficult to determine if these differences represent real population changes or are a reflection of differences in survey protocol. Harp trap placement, trapping later into the night, and surveying additional caves may have influenced bat capture rates. Previous bat surveys were conducted at all caves we surveyed and at additional caves. Male-biased sex ratios documented in our study during fall are consistent with previous research conducted in western Maryland (Gates et al. 1984; Marsh 1998) and in other areas of North America (Hall and Brenner 1968; Cope and Humphrey 1977; Schowalter 1980).

Table 1. Number of bats captured per hour at caves in western Maryland, 2004 and 2005.

Cave	Date	Hours Trapped	*Eptesicus fuscus*	*Myotis lucifugus*	*Myotis septentrionalis*	*Pipistrellus subflavus*	All species[a]
Crabtree Cave	4/15/2004	4.3	0.0	2.3	5.1	0.0	7.4
	4/18/2004	4.2	0.0	4.3	9.0	0.7	14.3
	5/5/2004	4.0	0.0	2.5	3.3	2.5	8.3
	9/23/2004	4.9	0.0	2.2	6.1	2.0	10.4
	10/7/2004	5.3	0.0	0.8	2.5	0.6	3.8
	10/27/2004	5.8	0.0	0.0	0.5	0.0	0.5
	4/5/2005	4.3	0.0	1.9	10.8	0.0	12.8
	4/12/2005	4.2	0.0	1.4	5.0	0.2	6.7
	4/21/2005	4.0	0.0	2.7	2.7	1.2	6.8
	Subtotal	41.0	0.0	1.9	4.8	0.8	7.5
Greises Cave	4/16/2004	4.3	0.0	8.1	14.7	0.2	23.0
	4/19/2004	4.2	0.0	6.9	9.5	1.0	17.4
	5/4/2004	4.0	0.0	7.5	1.8	4.0	13.3
	9/13/2004	4.7	0.0	20.9	6.2	3.8	30.9
	9/21/2004	4.9	0.0	7.6	3.7	5.9	17.1
	10/26/2004	5.8	0.0	0.9	1.0	0.0	1.9
	4/4/2005	4.3	0.0	4.2	14.7	0.2	19.1

Table 1. Continued

Cave	Date	Hours Trapped	*Eptesicus fuscus*	*Myotis lucifugus*	*Myotis septentrionalis*	*Pipistrellus subflavus*	All species[a]
Greises Cave (Continued)	4/11/2005	4.2	0.0	9.3	12.1	0.2	21.4
	4/19/2005	4.1	0.0	11.0	6.3	3.2	20.5
	Subtotal	40.5	0.0	8.3	7.5	2.0	17.8
John Friend Cave	4/17/2004	4.2	0.0	3.3	4.0	0.2	7.6
	4/20/2004	4.2	0.0	0.2	1.7	0.5	2.4
	4/28/2004	4.2	0.0	1.2	0.7	3.8	5.7
	9/22/2004	4.9	0.0	2.9	2.7	3.7	9.4
	10/6/2004	5.3	0.0	0.9	0.2	0.4	1.5
	10/28/2004	5.8	0.0	0.3	0.0	0.0	0.3
	4/6/2005	4.3	0.0	0.9	4.7	0.0	5.6
	4/14/2005	4.0	0.0	1.0	2.5	0.0	3.5
	5/4/2005	3.8	0.0	1.3	0.3	1.3	2.9
	Subtotal	40.7	0.0	1.3	1.8	1.1	4.2
Round Top Mine No. 4	8/9/2004	3.8	5.0	0.8	0.8	2.6	9.2
	Total	126.0	0.2	3.7	4.6	1.3	9.8

[a] Includes *Myotis leibii,* 1 female captured at Crabtree Cave on 18 April 2004, 1 male captured at John Friend Cave on 22 September 2004, and 1 female captured at Crabtree Cave on 5 April 2005.

Table 2. Bat captures at caves in western Maryland, 2004 and 2005.

Location	Date	Species	No. captures[a]	Male	Female
Crabtree Cave	4/15/2004	*Myotis lucifugus*	10	3	6
		Myotis septentrionalis	22	10	12
	4/18/2004	*Myotis leibii*	1	0	1
		Myotis lucifugus	18	4	14
		Myotis septentrionalis	38	28	10
		Pipistrellus subflavus	3	1	2
	5/5/2004	*Myotis lucifugus*	10	10	0
		Myotis septentrionalis	13	10	2
		Pipistrellus subflavus	10	1	8
	9/23/2004	*Myotis lucifugus*	11	10	1
		Myotis septentrionalis	30	22	8
		Pipistrellus subflavus	10	4	6
	10/7/2004	*Myotis lucifugus*	4	3	1
		Myotis septentrionalis	13	12	1
		Pipistrellus subflavus	3	3	0
	10/27/2004	*Myotis septentrionalis*	3	2	1
	4/5/2005	*Myotis leibii*	1	0	1
		Myotis lucifugus	8	2	6
		Myotis septentrionalis	46	27	19
	4/12/2005	*Myotis lucifugus*	6	3	3
		Myotis septentrionalis	21	11	10
		Pipistrellus subflavus	1	1	0
	4/21/2005	*Myotis lucifugus*	11	4	7
		Myotis septentrionalis	11	6	5
		Pipistrellus subflavus	5	0	5
Greises Cave	4/16/2004	*Myotis lucifugus*	35	7	26
		Myotis septentrionalis	63	37	25

Table 2. Continued

Location	Date	Species	No. captures[a]	Male	Female
Greises Cave (Continued)		*Pipistrellus subflavus*	1	0	1
	4/19/2004	*Myotis lucifugus*	29	6	23
		Myotis septentrionalis	40	31	9
		Pipistrellus subflavus	4	1	3
	5/4/2004	*Myotis lucifugus*	30	19	11
		Myotis septentrionalis	7	6	1
		Pipistrellus subflavus	16	1	15
	9/13/2004	*Myotis lucifugus*	98	81	17
		Myotis septentrionalis	29	19	10
		Pipistrellus subflavus	18	9	9
	9/21/2004	*Myotis lucifugus*	37	29	8
		Myotis septentrionalis	18	5	13
		Pipistrellus subflavus	29	12	17
	10/26/2004	*Myotis lucifugus*	5	3	1
		Myotis septentrionalis	6	3	3
	4/4/2005	*Myotis lucifugus*	18	4	14
		Myotis septentrionalis	63	44	19
		Pipistrellus subflavus	1	1	0
	4/11/2005	*Myotis lucifugus*	38	10	28
		Myotis septentrionalis	51	29	22
		Pipistrellus subflavus	1	0	1
	4/19/2005	*Myotis lucifugus*	45	5	40
		Myotis septentrionalis	26	22	4
		Pipistrellus subflavus	13	1	12
John Friend Cave	4/17/2004	*Myotis lucifugus*	14	6	8
		Myotis septentrionalis	17	3	14
		Pipistrellus subflavus	1	0	1
	4/20/2004	*Myotis lucifugus*	1	0	1

Table 2. Continued

Location	Date	Species	No. captures[a]	Male	Female
John Friend Cave (Continued)		*Myotis septentrionalis*	7	5	2
		Pipistrellus subflavus	2	0	1
	4/28/2004	*Myotis lucifugus*	5	4	1
		Myotis septentrionalis	3	3	0
		Pipistrellus subflavus	16	2	14
	9/22/2004	*Myotis leibii*	1	1	0
		Myotis lucifugus	14	10	4
		Myotis septentrionalis	13	5	6
		Pipistrellus subflavus	18	10	8
	10/6/2004	*Myotis lucifugus*	5	5	0
		Myotis septentrionalis	1	1	0
		Pipistrellus subflavus	2	2	0
	10/28/2004	*Myotis lucifugus*	2	0	2
	4/6/2005	*Myotis lucifugus*	4	1	3
		Myotis septentrionalis	20	17	2
	4/14/2005	*Myotis lucifugus*	4	1	3
		Myotis septentrionalis	10	8	2
	5/4/2005	*Myotis lucifugus*	5	3	2
		Myotis septentrionalis	1	1	0
		Pipistrellus subflavus	5	0	5
Round Top Mine No. 4	8/9/2004	*Eptesicus fuscus*	19	16	3
		Myotis lucifugus	3	3	0
		Myotis septentrionalis	3	1	2
		Pipistrellus subflavus	10	7	3
Total		*Eptesicus fuscus*	19	16	3
		Myotis leibii	3	1	2
		Myotis lucifugus	470	236	230
		Myotis septentrionalis	575	380	191
		Pipistrellus subflavus	169	56	111

[a] Discrepancies in total number of bats captured and sum of males and females are due to bats escaping before determination of sex.

Our big brown bat capture data are consistent with Marsh's (1998) findings in western Maryland. We captured big brown bats at Round Top Mine No. 4 in early August. The majority of big brown bats captured by Marsh (1998) were at the Round Top Mines and at Pinto Limestone Mines (Allegany County, Maryland) during July and August. Captures of female big brown bats indicate possible breeding activity occurring at the cave; female big brown bats typically do not use caves or mines during the summer maternity period (Kurta and Baker 1990). In Maryland, big brown bats typically hibernate in tunnels and limestone mines. However, occasionally a few are reported hibernating in caves, including Crabtree Cave, John Friend Cave, and Round Top Mines (Gates et al. 1984).

Little brown myotis, northern myotis, and eastern pipistrelles were captured at all surveyed caves. All 3 species have been documented hibernating in Crabtree Cave, Greises Cave, and John Friend Cave (Gates et al. 1984; D. Feller, Maryland Department of Natural Resources, personal communication). Little brown myotis and eastern pipistrelles have been observed hibernating in Round Top Mine No. 4 (Gates et al. 1984). During summer, male little brown myotis, northern myotis, and eastern pipistrelles may use caves and mines as roosts (Hall and Brenner 1968; Johnson et al. 2003). Female little brown myotis, northern myotis, and eastern pipistrelles typically do not roost in caves or mines during summer (Barbour and Davis 1969).

Our survey results, along with past bat surveys conducted in Maryland, indicate eastern small-footed myotis are exceedingly rare compared to other cave-dwelling species in western Maryland. Previously, eastern small-footed myotis have been documented hibernating in Crabtree Mine, Devils Den Cave, Greises Cave, and Round Top Mine No. 2 Cave (Gates et al. 1984; D. Feller, Maryland Department of Natural Resources, personal communication). Crabtree Cave likely contains hibernating eastern small-footed myotis, as evidenced by our spring captures and those of Gates et al. (1984). However, eastern small-footed myotis are difficult to census during hibernacula surveys because they hibernate in narrow crevices and under rock slabs (Best and Jennings 1977). Throughout their range, eastern small-footed myotis captures at caves or mines during summer are relatively uncommon compared to other cavernicolous bat species (Best and Jennings 1997; Johnson et al. 2003). During summer, eastern small-footed myotis roost in buildings, tunnels, under rock slabs, and in rock outcrops (Best and Jennings 1997). Eastern small-footed myotis have been observed roosting in rock outcrops in the High Rock area of Big Savage Mountain, Maryland, approximately 6 km from Crabtree Cave (D. Feller, Maryland Department of Natural Resources, personal communication). In late May 2005, a female eastern small-footed myotis was captured at New Germany State Park (Garrett County, Maryland), which is close to many rock outcrops (J. Johnson, unpublished data). The eastern small-footed myotis we serendipitously observed roosting at night in Crabtree Mine may have been using Crabtree Mine, Crabtree Cave, or other nearby caves, mines, or rock outcroppings as day roosts. Night roosts serve many functions including calling roosts for mating displays, perches for preying upon and consuming food, and as resting places between foraging bouts (Kunz 1982). Therefore, eastern small-footed myotis use of caves and mines in western Maryland may not be restricted to hibernation and summer day roosting.

Table 3. Sex ratio (male:female) of bats captured at caves in western Maryland, 2004 and 2005.

Cave	Date	*Eptesicus fuscus*	*Myotis lucifugus*	*Myotis septentrionalis*	*Pipistrellus subflavus*	All species[a]
Crabtree Cave	4/15/2004	—	0.50:1.00	0.83:1.00	—	0.72:1.00
	4/18/2004	—	0.29:1.00	2.80:1.00	0.50:1.00	0.85:1.00
	5/5/2004	—	10.00:0.00	5.00:1.00	0.13:1.00	2.10:1.00
	9/23/2004	—	10.00:1.00	2.75:1.00	0.67:1.00	2.40:1.00
	10/7/2004	—	3.00:1.00	12.00:1.00	3.00:0.00	9.00:1.00
	10/27/2004	—	—	2.00:1.00	—	2.00:1.00
	4/5/2005	—	0.33:1.00	1.42:1.00	—	1.12:1.00
	4/12/2005	—	1.00:1.00	1.10:1.00	1.00:0.00	1.15:0.00
	4/21/2005	—	0.57:1.00	1.20:1.00	0.00:5.00	0.59:1.00
	Subtotal	—	1.03:1.00	1.90:1.00	0.48:1.00	1.38:1.00
Greises Cave	4/16/2004	—	0.27:1.00	1.48:1.00	0.00:1.00	0.85:1.00
	4/19/2004	—	0.26:1.00	3.44:1.00	0.33:1.00	1.09:1.00
	5/4/2004	—	1.73:1.00	6.00:1.00	0.07:1.00	0.96:1.00
	9/13/2004	—	4.76:1.00	1.90:1.00	1.00:1.00	3.00:1.00
	9/21/2004	—	3.63:1.00	0.39:1.00	0.71:1.00	1.21:1.00
	10/26/2004	—	3.00:1.00	1.00:1.00	—	1.50:1.00
	4/4/2005	—	0.29:1.00	2.32:1.00	1.00:0.00	1.48:1.00
	4/11/2005	—	0.36:1.00	1.32:1.00	0.00:1.00	0.76:1.00
	4/19/2005	—	0.13:1.00	5.50:1.00	0.08:1.00	0.50:1.00
	Subtotal	—	0.98:1.00	1.85:1.00	0.43:1.00	1.16:1.00
John Friend Cave	4/17/2004	—	0.75:1.00	0.21:1.00	0.00:1.00	0.39:1.00
	4/20/2004	—	0.00:1.00	2.50:1.00	0.00:1.00	1.25:1.00
	4/28/2004	—	4.00:1.00	3.00:1.00	0.14:1.00	0.60:1.00
	9/22/2004	—	2.50:1.00	0.83:1.00	1.25:1.00	1.44:1.00
	10/6/2004	—	5.00:0.00	1.00:0.00	2.00:0.00	8.00:0.00
	10/28/2004	—	0.00:2.00	—	—	0.00:2.00

Table 3. Continued

Cave	Date	*Eptesicus fuscus*	*Myotis lucifugus*	*Myotis septentrionalis*	*Pipistrellus subflavus*	All species[a]
John Friend Cave (Continued)	4/6/2005	—	0.33:1.00	8.50:1.00	—	3.60:1.00
	4/14/2005	—	0.33:1.00	4.00:1.00	—	1.80:1.00
	5/4/2005	—	1.50:1.00	1.00:0.00	0.00:5.00	0.57:1.00
	Subtotal	—	1.25:1.00	3.60:1.00	0.48:1.00	1.44:1.00
Round Top Mine No. 4	8/9/2004	5.33:1.00	3.00:1.00	0.50:1.00	2.33:1.00	3.38:1.00
	Total	5.33:1.00	1.03:1.00	1.99:1.00	0.50:1.00	1.28:1.00

[a] Includes *Myotis leibii,* 1 female captured at Crabtree Cave on 18 April 2004, 1 male captured at John Friend Cave on 22 September 2004, and 1 female captured at Crabtree Cave on 5 April 2005.

Indiana myotis have been captured in small numbers at cave entrances during fall swarming in western Maryland, including Crabtree Cave, Crabtree Mine, Greises Cave, John Friend Cave, and Round Top Mines (Gates et al. 1984; Marsh 1998; D. Feller, Maryland Department of Natural Resources, personal communication). However, it remains unclear if Indiana myotis are hibernating in Maryland caves. There are 2 records of Indiana myotis at Round Top Mines, 1 in November and 1 in December (Gates et al. 1984). Indiana myotis have not been captured during spring emergence surveys in Maryland. The majority of Indiana myotis captures in Maryland have been in August, suggesting captured individuals likely were transients. It is unlikely that any of the caves we surveyed serve as significant Indiana myotis hibernacula. However, the numerous unexamined abandoned coal mines in western Maryland may serve as fall swarming sites and/or hibernacula for Indiana myotis. Several Priority 3 (occupied by <500 individuals) Indiana myotis hibernacula exist in neighboring counties in Pennsylvania and West Virginia (Clawson 2002). Indiana myotis tracked via radio-telemetry from a hibernaculum in Blair County, Pennsylvania, migrated to Carroll County, Maryland, in spring 2005 (D. Limpert, Maryland Department of Natural Resources, personal communication). However, it is unclear if these bats established maternity colonies in Maryland.

Bats exiting hibernation in spring may not return to their hibernaculum until the following fall (Hall and Brenner 1968; Gates et al. 1984). However, Cope and Humphrey (1977) observed swarming behavior exhibited by female Indiana myotis at their hibernaculum in spring. Chances of capturing exiting bats, particularly at caves where very few individuals of rare or endangered species might hibernate, may be unlikely. Although it is likely that bats captured at cave entrances during spring emergence hibernated in the respective caves, it is not inconceivable that they were transients (Myers 1964). Indiana myotis have not been captured at Maryland caves during spring emergence, but they are known to emerge from hibernation from mid-March through May in other parts of their range (Cope and Humphrey 1977; Hobson and Holland 1995; W. M. Ford, USDA Forest Service, personal communica-

tion). During spring in western Maryland, eastern small-footed myotis have been captured as early as mid-March and as late as mid-May. Bats may be more likely to hibernate at caves where they are captured during spring emergence than during fall swarming, although this has not been examined extensively. During fall swarming, bats can visit a cave many times (Fenton 1969; Marsh 1998), thus increasing the chance of capture. However, complete turnover in individuals captured on consecutive nights has been observed (Barbour and Davis 1969; Fenton 1969). Moreover, bats may not roost during the day in caves at which they were captured. In Canada, Fenton (1969) found that little brown myotis captured at one cave during fall swarming hibernated at a second cave >800 km away, although many hibernated within 160 km. During fall swarming in Maryland, Indiana myotis have been captured from early August to early December. Eastern small-footed myotis are thought to be among the last bat species to enter hibernation (Best and Jennings 1997). During fall, eastern small-footed myotis have been captured in Maryland from early July to mid October, with the majority of captures recorded in August.

Acknowledgments

We thank L. Allard, D. Feller, M. Ford, H. Kahler, D. Limpert, K. Lott, A. Price, J. Rodrigue, R. Rodriguez, and S. Shourds for assisting us during our survey efforts. The Nature Conservancy, Cumberland Bowhunters, and Maryland Department of Natural Resources provided access to the caves. Funding was provided by Maryland Department of Natural Resources, Natural Heritage Program. This article is Scientific Contribution Number 4002 of the University of Maryland Center for Environmental Science, Appalachian Laboratory.

Literature Cited

Barbour, R. W., and W. H. Davis. 1969. *Bats of America*. University Press of Kentucky, Lexington, Kentucky. 286 pp.

Best, T. L., and J. B. Jennings. 1997. *Myotis leibii*. *Mammalian Species* 547:1–6.

Clawson, R. L. 2002. Trends in population size and current status. Pages 2–8 *in* A. Kurta, and J. Kennedy (eds). *The Indiana Bat: Biology and Management of an Endangered Species*. Bat Conservation International, Austin, Texas.

Cope, J. B., and S. R. Humphrey. 1977. Spring and autumn swarming behavior in the Indiana bat, *Myotis sodalis*. *Journal of Mammalogy* 58:93–95.

Fenton, M. B. 1969. Summer activity of *Myotis lucifugus* (Chiroptera: Vespertilionidae) at hibernacula in Ontario and Quebec. *Canadian Journal of Zoology* 47:597–602.

Franz, R., and D. Slifer. 1976. *Caves of Maryland*. Maryland Geological Survey, Education Series, Number 3. 120 pp.

Gates, J. E., G. A. Feldhamer, L. A. Griffith, and R. L. Raesly. 1984. Status of cave-dwelling bats in Maryland: Importance of marginal habitats. *Wildlife Society Bulletin* 12:162–169.

Griffith, L. A., and J. E. Gates. 1985. Food habits of cave-dwelling bats in the central Appalachians. *Journal of Mammalogy* 66:451–460.

Hall, J. S., and F. J. Brenner. 1968. Summer netting of bats at a cave in Pennsylvania. *Journal of Mammalogy* 49:779–781.

Hobson, C. S., and J. N. Holland. 1995. Post-hibernation movement and foraging habitat of a male Indiana bat, *Myotis sodalis* (Chiroptera: Vespertilionidae), in western Virginia. *Brimleyana* 23:95–101.

Johnson, J. B., P. B. Wood, and J. W. Edwards. 2003. Survey of abandoned coal mines for bats at the New River Gorge National River and Gauley River National Recreation Area. Unpublished report prepared for the U.S. National Park Service, Department of the Interior, Glen Jean, West Virginia. 95 pp.

Kunz, T. H. 1982. Roosting ecology of bats. Pages 1–55 *in* T. H. Kunz (ed). *Ecology of bats*. Plenum Press, New York, New York.

Kurta, A., and R. H. Baker. 1990. *Eptesicus fuscus*. *Mammalian Species* 356:1–10.

Marsh, B. D. 1998. Prehibernal weight gain and activity of temperate cavern-dwelling bats in western Maryland and southwestern Pennsylvania. MS Thesis, Frostburg State University, Frostburg, Maryland. 237 pp.

Menzel, M. A., J. M. Menzel, S. B. Castleberry, J. Ozier, W. M. Ford, and J. W. Edwards. 2002. Illustrated key to skins and skulls of bats in the Southeastern and Mid-Atlantic States. U.S. Department of Agriculture Forest Service, General Technical Report SRS-68. 10 pp.

Myers, R. F. 1964. Ecology of three species of Myotine bats in the Ozark Plateau. PhD Dissertation, University of Missouri, Columbia, Missouri. 209 pp.

Paradiso, J. L. 1969. *Mammals of Maryland*. United States Department of the Interior, Bureau of Sport Fisheries and Wildlife, North American Fauna, Number 66. 193 pp.

Racey, P. 1988. Reproductive assessment in bats. Pages 31–45 *in* T. H. Kunz (ed). *Ecological and behavioral methods in the study of bats*. Smithsonian Institution Press, Washington DC. 533 pp.

Raesly, R. L., and J. E. Gates. 1987. Winter habitat selection by north temperate cave bats. *American Midland Naturalist* 118:15–31.

Schowalter, D. B. 1980. Swarming, reproduction, and early hibernation of *Myotis lucifugus* and *M. volans* in Alberta, Canada. *Journal of Mammalogy* 61:350–354.

The Dytiscidae and Hydrophilidae (Insecta: Coleoptera) of Eastern Neck National Wildlife Refuge, Maryland

C. L. Staines[1] and S. L. Staines

Department of Entomology, MRC 187, National Museum of Natural History, Smithsonian Institution, P. O. Box 37012, Washington, DC 20013-7012, USA

Abstract.—Inventory work conducted at Eastern Neck National Wildlife Refuge, Rock Hall, Maryland from April to September 2003 found 17 species of Dytiscidae and 25 species of Hydrophilidae. This represents 22.4% of the Maryland fauna. The most unusual find was the woodland pool specialist *Agabetes acuductus* Harris (Dytiscidae), a candidate for endangered species in Maryland.

Introduction

Beetles from a number of families are found in aquatic habitats. In North America alone there are ten different families in which both larvae and adults of nearly all species are aquatic, three in which at least one stage is aquatic, and two in which the larvae occur in water or in the underwater parts of plants and the adults are semiaquatic. Members of these families all live in fresh, saline, and mineral inland waters. Species of five other families live in the intertidal zone of ocean beaches. In addition, there are many species which burrow in wet mud and sand or hunt and hide under debris and stones at the water's edge.

The majority of water beetles prefer shallow water, where they hide among aquatic plants and underwater debris near the shore. Few species occur in deep water and none are found inhabiting the open ocean.

Members of the family Dytiscidae are found in lentic and lotic habitats. They are extremely well-adapted to aquatic life. Many are strong swimmers. Dytisids are predators and scavengers as larvae and adults. Larger species often feed on fish, anuran larvae or other small vertebrates. Smaller species are effective predators on invertebrates, especially mosquito larvae. Many species are good fliers and are able to quickly colonize new bodies of water or disperse when their habitat dries up (Wilson 1923).

Oviposition occurs terrestrially usually in either moss or debris or in cracks in wood. There are three larval instars and each is aquatic. Larvae, as well as adults, must surface for oxygen though there is circumstantial evidence that some species do not need to surface; the larvae of *Coptotomus* have abdominal gills. Pupation generally occurs on the land near the water in a small earthen cell (Wilson 1923).

The North American dytiscid fauna of 475 species is well studied (Larson et al. 2000). There are 84 species reported from Maryland (Staines 1986a).

Members of the family Hydrophilidae are mainly aquatic but the subfamily Sphaeridiinae is terrestrial and lives in animal dung, fungi, and decaying plant material. Aquatic species are found in stagnant pools, littoral areas of lakes and ponds, shallow quiet water of streams, and springs. Aquatic hydrophilids are predaceous as

[1]stainesc@si.edu

larvae; adults are predaceous on snails or other small invertebrates, omnivorous or phytophagous. A number of aquatic species are important predators of mosquito larvae. *Hydrophilus triangularis* Say has been reported as a pest in fish hatcheries.

The 225 North American hydrophilids are fairly well known (Van Tassell 2001). There are 103 species reported from Maryland (Staines 1986b). Of these, 75 are aquatic and 28 terrestrial.

Eastern Neck National Wildlife Refuge in Rock Hall, Maryland (39°0149′N, 76°1341W) is a 2285 acre Chesapeake Bay island at the mouth of the Chester River. Habitats include 1000 acres of brackish tidal marsh, 600 acres of cropland, 500 acres of forest, and 40 acres of open water impoundments. Here we report on a survey of the dytiscid and hydrophilid beetles of Eastern Neck National Wildlife Refuge.

Methods

Aquatic beetles were collected by three methods. A standard aquatic net was used along pool margins as well as in deeper or more interior sections of the pool. The "floatation" method involved stirring and agitating the submerged leaf litter along the pool margin by hand and holding it submerged for about a minute, causing beetles to float to the surface where they were easily visible and could be captured with a fine-mesh net. This is very effective for the smaller species. Finally, black lights were used to capture numerous species. Inventories were conducted from 22 Apr to 20 Sept 2004. Voucher specimens have been placed in the collections of Eastern Neck National Wildlife Refuge and National Museum of Natural History, Smithsonian Institution.

Results

A total of 17 species of Dytiscidae and 25 species of Hydrophilidae were found. In the following listing of species each entry contains general habitat description for the species, endangerment status in Maryland and at the federal level, and details of specific collection locations on the island.

Dytiscidae

Agabetes acuductus (Harris) is a woodland pool specialist (Spangler and Gordon 1973) and is a candidate for threatened or endangered status in Maryland (Anonymous 2003); adults are sometimes taken at lights. A single specimen was taken at black light near Headquarters Pond.

Agabus gagates Aubé is most commonly found in woodland pools as well as beaver ponds, flooded pastures, and stream margins; adults are taken at lights (Michael and Matta 1977). A single specimen was taken at black light along Duck Inn Trail.

Celina slossoni Mutchler is found in temporary pools; adults are attracted to lights (Young 1979). This species was common at black light at Boxes Point, GTR 2, and GTR 3.

Copelatus glyphicus (Say) is abundant in temporary pools; adults are commonly taken at lights (Spangler 1962). This species was abundant at black light throughout the island.

Coptotomus longulus LeConte occurs in just about any type of pool or pond (Hilsenhoff 1980). This species was common near Ingleside Recreation Area.

Cybister fimbriolatus Say prefers the deeper water of ponds and ditches but is also found in shallower water; adults are attracted to light (Michael and Matta 1977). A single specimen was taken at black light along Ingleside Road.

Hydaticus bimarginatus (Say) is found in woodland pools and thickly vegetated ditches (Roughley and Pengelly 1981). This species was common throughout the island.

Hygrotus nubilis (LeConte) is collected in a variety of aquatic habitats, including dense emergent grasses and rushes along the margins of small pools, pools in gravel pits, and ponds; primarily a summer species, most specimens are collected after June (Larson et al. 2000). This species was abundant throughout the island.

Laccophilus fasciatus rufus Melsheimer is most commonly found in exposed, muddy or silt bottom temporary ponds; it is a pioneer species found in newly formed aquatic habitats (Zimmerman 1970). This species was common throughout the island.

Liodessus affinis (Say) is found in ditches; adults are attracted to light (Larson and Roughley 1990). A single specimen was taken at black light near Refuge Headquarters.

Liodessus flavicollis (LeConte) is found in submerged mats of algae and aquatic plants (Larson and Roughley 1990). This species was common in Headquarters Pond.

Matus bicarinatus (Say) is found in ponds and streams (Young 1953). A single specimen was taken at black light near GTR 2.

Neoporus clypealis (Sharp) is a generalist, found in almost any aquatic habitat; adults are attracted to lights (Hilsenhoff 1995). A single specimen was taken at black light near Refuge Headquarters.

Rhantus calidus (Fabricius) is found in woodland pools, open grassy marshes, ponds, and muddy pools at stream margins (Zimmerman and Smith 1973). This species was common in the Maintenance Area Pond.

Thermonectus basillaris (Harris) is most commonly found in temporary pools with clear water and no vegetation; it is considered a pioneer species; adults are attracted to lights (Michael and Matta 1977). This species was common throughout the island.

Uvarus granarius (Aubé) is found on mats of vegetation along shallow bodies of water; they are especially common in woodland pools and bogs (Larson et al. 2000). A single specimen was taken at black light in Ingleside Recreation Area.

Uvarus lacustris (Say) is often common in small muddy or clay bottomed pools and in shallow, sun-warmed water along the edges of large ponds (Larson et al. 2000). This species was common in vernal pools along Headquarters Road.

Hydrophilidae

Berosus exiguus Say is found in the margins of rainwater pools and other temporary situations but it not commonly found (Van Tassell 1966). This species was abundant near Refuge Headquarters, Boxes Point, and Duck Inn Trail.

Berosus infuscatus LeConte is the commonest species in the area and is found in a wide variety of pools and ponds (Van Tassell 1966). This species was abundant throughout the island.

Berosus peregrinus (Herbst) prefers quiet water along streams or ditches but can be occasionally found in temporary pools (Van Tassell 1966). Two specimens were taken in vernal pools at Boxes Point and Wildlife Trail.

Cercyon analis (Paykull) is found on carrion, in fungi, and in compost piles; adults are attracted to lights (Smetana 1978). A single specimen was taken at black light at Boxes Point.

Cercyon praetextatus (Say) is found on carrion and dung; adults are attracted to lights (Smetana 1974). A single specimen was taken at black light at Refuge Headquarters.

Cercyon pygmaeus (Illiger) is found in dung, fungi, carrion, and compost piles; adults are attracted to lights (Smetana 1978). A single specimen was taken at black light at Ingleside Recreational Area.

Cercyon roseni Knisch is associated with *Carex* swamps and wet moss; adults have also been collected in leaf litter and debris; they are attracted to lights (Smetana 1978). This species was common at black light at Refuge Headquarters.

Enochrus cinctus (Say) is commonly collected in very shallow woodland temporary pools with abundant rotting vegetation (Gunderson 1978). This species was abundant on the northern half of the island.

Enochrus consortus Green is not common but found in pools with a layer of debris on the bottom (Gunderson 1978). This species was abundant at black light along Wildlife Trail.

Enochrus ochraceus (Melsheimer) is a widespread and locally abundant species; they are sometimes collected in large numbers in any weedy or debris clogged shallow water (Gunderson 1978). A single specimen was taken at black light along Wildlife Trail.

Enochrus perplexus (LeConte) is common in temporary pools of various types; it flies readily when taken from water (Gunderson 1978). This species was common throughout the island.

Enochrus pygmaeus nebulosus Say is found in quiet waters with rotting leaves and other plant debris (Gunderson 1978). This species was common throughout the island.

Helocombus bifidus (LeConte) is found in streams, ditches, woodland pools, and edges of lakes; adults are attracted to lights (Perkins and Spangler 1981). Two specimens were collected- one in a vernal pool at Bogles Wharf and the second at black light at GTR 2.

Hydrobius tumidus LeConte is found in woodland ponds with rotting vegetation (Matta 1974). A single specimen was taken in a vernal pool along Wildlife Trail.

Hydrochara obtusata (Say) adults commonly come to lights (Smetana 1980). This species was abundant at black light at Boxes Point and along Wildlife Trail.

Hydrochara soror Smetana is found on ponds, streams, and ditches; adults commonly come to lights (Smetana 1980). This species was abundant throughout the island.

Hydrochus excavatum LeConte is a coastal plain species which is found in a variety of pools, ponds, and streams; adults are attracted to lights (Hellman 1975). A single specimen was taken at black light at Boxes Point.

Hydrochus neosquamifer Smetana is found in pools and ponds; adults are attracted to lights (Smetana 1988). This species was common at black light at Boxes Point.

***Hydrochus* sp.** Hellman (1975) revised this genus but never published the dissertation. Makhan (1994, 1995, 2001, 2002) has described a number of Hellman's species. However, Makhan's descriptions and illustrations are of such poor quality that specimens can not be assigned to a species. A single specimen was taken at black light at Boxes Point.

Hydrophilus ovatus (Gemminger and Harold) is usually found in deep water with considerable vegetation; uncommonly collected; except at black light (Wilson 1923). This species was uncommon but taken at black light throughout the island.

Hydrophilus triangularis Say is found in large, deep ponds; adults are attracted to light (Wilson 1923). This species was common at black light along Ingleside Road and Wildlife Trail.

Paracymus subcupreus (Say) is found in a wide variety of aquatic habitats but prefers shallow, standing water with abundant organic matter (Wooldridge 1966). A single specimen was taken at black light at Boxes Point.

Tropisternus blatchleyi d'Orchymont seems to prefer shallow pools and ponds but may be found in any quiet water habitat; adults are attracted to lights (Matta 1974). This species was common at black light throughout the island.

Tropisternus lateralis nimbalis (Say) is very common and can be found in shallow standing water; it prefers areas with dense rooted vegetation and may occur in running water if the vegetation at the margin is thick enough adults are attracted to lights (Matta 1974). This species was abundant at black light throughout the island.

Tropisternus striolatus LeConte is found in shallow standing water with other *Tropisternus* species; adults are attracted to lights (Matta 1974). This species was common at black light throughout the island.

Discussion

The 17 species of Dytiscidae and 25 species of Hydrophilidae represent 22.4% of the known Maryland fauna. This indicates a diverse and healthy water beetle fauna for Eastern Neck National Wildlife Refuge. Only *Agabetes acuductus* is considered rare but many of the other species have not been previously reported from Kent County. The data from this project has been archived with the Refuge and will hopefully be the foundation of continued monitoring activity to track any changes in populations and species composition.

Acknowledgments

Funding for the inventory work was provided by a grant from the National Fish and Wildlife Foundation and the Friends of Eastern Neck National Wildlife Refuge. Special thanks to the volunteers who assisted with the inventory work.

Literature Cited

Anonymous. 2003. Rare, threatened, and endangered animals of Maryland. Maryland Department of Natural Resources. Wildlife and Heritage Service. http://www.dnr.state.md.us/wildlife.

Gunderson, R. W. 1978. Nearctic *Enochrus* biology, keys, descriptions, and distribution (Coleoptera: Hydrophilidae). Privately published. 54 pp.

Hilsenhoff, W. L. 1980. *Coptotomus* (Coleoptera: Dytiscidae) in eastern North America with descriptions of two new species. *Transactions of the American Entomological Society* 105:461–471.

_____. 1995. Dytiscidae and Noteridae of Wisconsin (Coleoptera). VI. Distribution, habitat, life cycle, and identification of species of *Hydroporus* Clairville sensu lato (Hydroporinae). *Great Lakes Entomologist* 28:1–23.

Hellman, J. L. 1975. A taxonomic revision of the genus *Hydrochus* of North America, Central America, and West Indies. Unpublished PhD Dissertation, University of Maryland, College Park, Maryland. 441 pp.

Larson, D. J., Y. Alarie, and R. E. Roughley. 2000. *Predacious diving beetles (Coleoptera: Dytiscidae) of the Nearctic Region, with emphasis on the fauna of Canada and Alaska.* NRC Press. Ottawa, Canada. 982 pp.

Larson, D. J., and R. E. Roughley. 1990. A review of the species of *Liodessus* Guignot of North America north of Mexico with the description of a new species (Coleoptera: Dytiscidae). *Journal of the New York Entomological Society* 98:233–245.

Makhan, D. 1994. Thirty-five new *Hydrochus* species from the Old and New World (Coleoptera: Hydrophilidae). *Annales Historico-Naturales Musei Nationalis Hungarici* 86:29–42.

_____. 1995. Descriptions of six new species of *Hydrochus* from South and North America (Coleoptera, Hydrochidae). *Zoological Studies* 34:18–20.

_____. 2001. A new genus, *Soesilius*, and a new species of Hydrochidae (Coleoptera) from America. *Russian Entomological Journal* 10: 389–393.

_____. 2002. Hydrochidae (Coleoptera) from North America with description of *Hydrochus pajnii* sp. nov. and *Hydrochus yadavi* sp. nov. Pages 51–53 *in* R. C. Sobti and J. S. Yadav (eds). *Some Aspects on the Insight of Insect Biology*. Narendra Publishing House, Delhi, India.

Matta, J. F. 1974. The aquatic Hydrophilidae of Virginia (Coleoptera: Polyphaga). *Virginia Polytechnic Institute and State University, Research Bulletin* 94. 44 pp.

Michael, A. G., and J. F. Matta. 1977. The Dytiscidae of Virginia (Coleoptera: Adephaga) (Subfamilies: Laccophilinae, Colymbetinae, Dytiscinae, Hydaticinae, and Cybistrinae). *Virginia Polytechnic Institute and State University, Research Bulletin* 124. 53 pp.

Perkins, P. D., and P. J. Spangler. 1981. A description of the larvae of *Helocombus bifidus* (Coleoptera: Hydrophilidae). *Pan-Pacific Entomologist* 57:52–56.

Roughley, R. E., and D. H. Pengelly. 1981. Classification, phylogeny, and zoogeography of *Hydaticus* Leach (Coleoptera: Dytiscidae) of North America. *Quaestiones Entomologicae* 17:249–309.

Smetana, A. 1978. Revision of the subfamily Sphaeridiinae of America north of Mexico (Coleoptera: Hydrophilidae). *Memoirs of the Entomological Society of Canada* 105:1–292.

_____. 1980. Revision of the genus *Hydrochara* Berth. (Coleoptera: Hydrophilidae). *Memoirs of the Entomological Society of Canada* 111:1–100.

_____. 1988. Review of the family Hydrophilidae of Canada and Alaska (Coleoptera). *Memoirs of the Entomological Society of Canada* 142:1–316.

Spangler, P. J. 1962. Natural history of Plummers Island, Maryland. XIV. Biological notes and description of the larva and pupa of *Copelatus glyphicus* (Say) (Coleoptera: Dytiscidae). *Proceedings of the Biological Society of Washington* 75:19–24.

Spangler, P. J., and R. D. Gordon. 1973. Descriptions of the larvae of some predacious water beetles (Coleoptera: Dytiscidae). *Proceedings of the Biological Society of Washington* 86:261–278.

Staines, C. L. 1986a. A preliminary checklist of the Hydradephaga (Coleoptera) of Maryland. *Insecta Mundi* 1:118–155.

_____. 1986b. A preliminary checklist of the Hydrophiloidea (Coleoptera) of Maryland. *Insecta Mundi* 1:259–260.

Van Tassell, E. R. 1966. Taxonomy and biology of the subfamily Berosinae of North and Central America and the West Indies. Unpublished PhD Thesis. Catholic University of America, Washington, DC.

_____. 2001. Hydrophilidae Latreille, 1802. Pages 187–208 *in* R. H. Arnett and M. C. Thomas (eds). *American beetles volume 1: Archostemata, Myxophaga, Adelphaga, Polyphaga: Staphyliniformia.* CRC Press, New York.

Wilson, C. B. 1923. Water beetles in relation to pondfish culture, with life histories of those found in fishponds at Fairport, Iowa. *Bulletin of the Bureau of Fisheries* 39:231–345.

Wooldridge, D. P. 1966. Notes of Nearctic *Paracymus* with descriptions of new species (Coleoptera: Hydrophilidae). *Journal of the Kansas Entomological Society* 39:712–725.

Young, F. N. 1953. Two new species of *Matus*, with a key to the known species and subspecies of the group (Coleoptera: Dytiscidae). *Annals of the Entomological Society of America* 46:49–55.

_____. 1979. A key to the Nearctic species of *Celina* with descriptions of new species (Coleoptera: Dytiscidae). *Journal of the Kansas Entomological Society* 52:820–830.

Zimmerman, J. R. 1970. A taxonomic revision of the aquatic beetle genus *Laccophilus* (Dytiscidae) of North America. *Memoirs of the American Entomological Society* 26:1–275.

Zimmerman, J. R., and R. L. Smith. 1975. The genus *Rhantus* (Coleoptera: Dytiscidae) in North America. Part I. General account of the species. *Transactions of the American Entomological Society* 101:33–123.

First Records of the Rock Vole (*Microtus chrotorrhinus*) in Maryland

Walter Bulmer[1,2], Ralph P. Eckerlin[2], and Ed Thompson[3]

[2]*Natural Sciences Division, Northern Virginia Community College, Annandale, Virginia 22003*

[3]*Natural Heritage Program, Maryland Department of Natural Resources, Annapolis, MD 20401*

Abstract.——Two specimens of the rock vole, *Microtus chrotorrhinus* were trapped on the Hoye Crest of Backbone Mountain in Garrett County, Maryland. Another specimen trapped in Garrett County in 1987 is also documented. This is the first report of the rock vole from Maryland.

Introduction

The rock vole, or yellownose vole, *Microtus chrotorrhinus* (Miller, 1894) has a distribution from Labrador westward across Canada to Minnesota and southward at higher elevations through the New England states to Tennessee and North Carolina (Hall, 1981). Populations in the southern extent of the range are fragmented and appear isolated. No published records of the rock vole exist for the state of Maryland (Paradiso, 1969) and the species is listed as "endangered" under Maryland's State Endangered Species Law (Code of Maryland Regulations 08.02.12). In adjacent states there are numerous records from West Virginia and Pennsylvania but only three sites in Virginia have been identified where the rock vole exists (Orrock et al., 1999). Typical habitat for the rock vole is a talus slope with moss-covered rocks (Kirkland and Jannett, 1982). This restricted habitat may be limited in the southern unglaciated Appalachians and hence, accounts for the fragmented distribution of populations. Here we report on one museum specimen and a second collection of two individuals during a study of the ectoparasite communities of mammals from western Maryland.

Materials and Methods

On 22 December 1987, employees of the Natural Heritage Program of the Maryland Department of Natural Resources (Ed Thompson and Scott Bates) set 50 Victor Pro snap traps baited with a mixture of peanut butter, dried grits and anise oil approximately 15 m from the North Prong of Lostland Run (a first order stream in the Potomac River drainage) at an elevation of 762 m (2500 feet). On 6 September 2003 a trapline of 42 Sherman live traps and 8 Museum Special snap traps was established for one night. Traps were set next to fallen logs, and among moss and lichen covered rocks on the trail just south and north of the Hoye Crest summit (elevation 1013 m), Backbone Mountain, Garrett County, Maryland. All traps were baited with peanut butter and rolled oats. Two weeks later, on 20 September 2003, the same area was trapped again for a single night this time using 60 Museum Special and 28 Sherman traps again baited with a mixture of peanut butter and oats. Animals captured alive during the 2003 trapping effort were brushed over a white pan to collect ectoparasites

[1]wbulmer@nvcc.edu

and were then identified, sexed, and released. Dead animals were individually placed into clean plastic bags, which were placed on ice and brought to the laboratory. All animals were processed for ectoparasites and representatives of all species were measured, weighed, and prepared as standard museum study skins with cleaned skull. Mammal names follow Kays and Wilson (2002).

Results and Discussion

Trapping during 1987 yielded a single specimen of *M. chrotorrhinus* that was subsequently deposited in the Carnegie Museum of Natural History (CMNH catalog number 103535), but the capture had not been reported in the scientific literature, to date. The capture site was among moss covered sandstone boulders under a canopy of yellow birch, *Betula alleghaniensis*, and hemlock, *Tsuga canadensis*. The trap was approximately 56 cm below the surface. The site is approximately 15 m from the North Prong of Lostland Run (a first order stream in the Potomac River drainage) at an elevation of 762 m. Water could be heard flowing under the boulders. A dense stand of hemlock occurs adjacent to the capture site along the stream. Other trees occurring within the boulder field include red oak, *Quercus rubra*, chestnut oak, *Q. montana*, black birch, *Betula lenta*, and red maple, *Acer rubrum*. The boulder habitat occupies an area of approximately 0.5 hectares. The CMNH collection also contains 9 Pennsylvania and 19 West Virginia rock vole specimens.

A subadult female rock vole weighing 32.6g was collected in a Museum Special trap on 6 September 2003. Standard external measurements were total length,147 mm; tail, 40 mm; hind foot, 20 mm; ear, 13 mm. On 27 September 2003 a second specimen was caught in a Museum Special, an adult female weighing 40.8g with corresponding external measurements of total length, 145 mm; tail, 40 mm; hind foot, 20 mm; ear, 12 mm. Study skins and skulls are deposited in the collections at Northern Virginia Community College as accession numbers 8201 and 8202. Both specimens were collected from the same general area about 50 m south of the Hoye Crest marker. The collection site was among boulders, some of which were moss covered, on an east-facing slope within 50 m of the West Virginia boundary. The forest in the area of capture is a northern hardwood type which was not specifically analyzed for its component species. However, some of the species present included red oak, *Quercus rubra*, striped maple, *Acer pennsylvanicum*, American basswood, *Tilia americana*, cherry, *Prunus* sp., and American beech, *Fagus grandifolia*. No conifers were present. Some areas of the forest understory were extensively covered by ferns and there was considerable leaf litter on the forest floor.

The adult rock vole had a lesion in the inguinal region of the abdomen that appeared to be the wound left by a recently emerged botfly (Cuterebridae) larva. Botflies have been reported from the rock vole in the Great Smoky Mountain National Park (Komarek and Komarek, 1938) and in New York (Martin, 1972) but were not identified to species in those studies. No ectoparasites were found on the two voles we collected, although several species of fleas and mites regularly occur on rock voles (Martin, 1972).

Other small mammals collected in the same area were southern red-backed vole (*Clethrionomys gapperi*), (13); North American deermouse (*Peromyscus manicula-*

tus), (10); and northern short-tailed shrew (*Blarina brevicauda*), (1). Orrock and Pagels (2003) found *C. gapperi* to be the best indicator of habitat likely to support rock voles. Other investigators have reported southern red-backed voles to be ecological associates of the rock vole (Kirkland and Jannett 1982, Handley and Pagels 1991, Linzey 1998).

Microtus chrotorrhinus is known from fossil remains found in caves in the adjoining states of West Virginia, Pennsylvania, and Virginia but not from Maryland (Zakrzewski 1985). There are also extant populations of the rock vole in these adjoining states. Orrock and Pagels (2003) sampled 349 sites in Virginia of which 59 were deemed to have habitat suitable for rock voles because of the presence of yellow birch (*Betula alleghaniensis*). Among these 59 sites they found rock voles at three. The work of Orrock and Pagels (2003) is the most extensive to date to identify habitat requirements for *M. chrotorrhinus*.

The literature on the food of rock voles was summarized recently by Linzey (1998). In all reports cited, vegetation was the sole food type found. We examined the stomach contents of the 2 rock voles from Backbone Mountain using dissecting and compound microscopes. No insect or other invertebrate animal items were detected. The stomachs were negative for lichens and mosses but contained highly macerated green material containing parenchyma, tracheid, and vessel cells from unidentified angiosperms.

Since 1987, the Natural Heritage Program has discovered several additional sites for the rock vole in Maryland. All of them are restricted to higher elevations of Garrett County. Detailed information on these capture sites are to be included in a forthcoming publication.

Acknowledgements

We thank the Maryland Department of Natural Resources for issuing scientific collecting permit number SCO-35660. Suzanne McLaren of the CMNH made rock vole records of that museum available.

Literature Cited

Hall, E. R. 1981. *The Mammals of North America*. Wiley Interscience, New York, NY.

Handley, C. O., Jr. and J. F. Pagels. 1991. Rock Vole: *Microtus chrotorrhinus carolinensis* Komarek. Pages 589–591 *in* K. Terwilliger (coord.). *Virginia's Endangered Species*. McDonald and Woodward Publishing Co., Blacksburg, VA.

Kays, R. W. and D. E. Wilson. 2002. *Mammals of North America*. Princeton University Press. Princeton, NJ.

Kirkland, G. L., Jr. and F. J. Jannett, Jr. 1982. *Microtus chrotorrhinus*. Mammalian Species 180:1–5.

Komarek, E. V. and R. Komarek. 1938. Mammals of the Great Smoky Mountains. Bulletin of the Chicago Academy of Science 5:137–162.

Linzey, D. W. 1998. *The Mammals of Virginia*. McDonald and Woodward Publishing Co., Blacksburg, VA.

Martin, R. E. 1972. Parasites and diseases of the rock vole. Occasional Papers of the University of Connecticut, Biological Science Series 2:107–113.

Orrock, J. L., E. K. Harper, J. F. Pagels, and W. J. McShea. 1999. Additional records of the rock vole, *Microtus chrotorrhinus* (Mammalia: Muridae), in Virginia. Banisteria 14:36–38.

Orrock, J. L. and J. F. Pagels. 2003. Tree communities, microhabitat characteristics, and small mammals associated with the endangered rock vole, *Microtus chrotorrhinus*, in Virginia. Southeastern Naturalist 2:547–558.

Paradiso, J. L. 1969. *Mammals of Maryland.* North American Fauna 66:1–193.

Zakrzewski, R. J. 1985. The fossil record. Pages 1–51 *in* R. H. Tamarin (ed.). *Biology of the New World Microtus*. Special Publication No. 8, The American Society of Mammalogists.

Instructions to Authors

The Maryland Naturalist is a peer reviewed biannual publication of the Natural History Society of Maryland. *The Maryland Naturalist* seeks to publish original research concerning the natural history and ecology of Maryland and adjacent states. Two types of manuscripts are considered for publication: 1) full length contributions describing the results of original research, and 2) short communications, reporting unusual natural history observations. Full-length manuscripts may deal with subject matter including, but not limited to, the geology, chemistry, and biology of the Maryland region. Short communications should describe unusual observations; for example, the occurrence of a rare organism or geological formation, or the occurrence of an organism or population that extends the known range of a species. *The Maryland Naturalist* will occasionally publish biographies of naturalists of regional significance. Individuals wishing to write a biography should write the editor at the following address: Department of Biological Sciences, Towson University, Towson, Maryland 21252; jsnodgrass@naturalhistory.org.

The original and three copies of all manuscripts should be submitted to *The Maryland Naturalist,* The Natural History Society of Maryland, 2643 North Charles Street, Baltimore, Maryland 21218-4590. Manuscripts should be typed on 8½" × 11" paper, double spaced throughout (including tables), with 1" margins on all sides, and all pages (including tables) should be numbered. Use metric units unless English measures are appropriate, in which case metric equivalents should be given in parentheses. A cover page with the title of the paper, addresses of all authors, and the name and complete address (including zip code and email) of the corresponding author should be included with the original manuscript and all copies.

Full-length contributions should have an abstract of no more than 300 words. Short communications should not have an abstract and should be limited to 2500 words. Avoid undue formatting of the manuscript. Limit italicized text to scientific names of species. Literature citations in the text should use the name-and-year system (e.g., one author-Smith 1980; two-authors-Smith & Smith 1980; more than two authors Smith et al. 1980) with semicolons separating individual citations (e.g., Smith 1980; Jones et al. 1982), and the Literature Cited section should follow the main body of the manuscript. Consult a recent issue of the journal for formatting of the Literature Cited section. All tables should appear on separate pages following the literature cited, have brief headings, be double spaced, and not include vertical lines. All figures should be printed on separate pages and lettering should be uniform among figures. Photographs and hand draw illustrations should be mounted on standard size paper or backing board and mailed flat. All figures should be clear and free of smudges and correction marks. Only black and white figures, illustrations and photographs will be published. Figures should be legible after 50-66% reduction. Figure legends should be typed on a separate page, double-spaced, and appear just before the figures. The author's name and figure number should be lightly penciled on the back of each figure.

In their cover letter authors should identify at least three potential reviewers with expertise in the subject matter of the manuscript and without close personal working ties with the author(s). The cover letter should also indicate that the manuscript has not been published previously and is not being considered for publication elsewhere.

Authors should indicate the intended manuscript category in their cover letter. Voluntary page charges will be assessed when authors have grant, institute, or other funds available. Ability to pay page charges will in no way influence whether or not a manuscript is accepted for publication. Do not include page charge information in your cover letter.

Upon manuscript acceptance, authors will be required to send an electronic version of their manuscript to the copy editor. In order of preference, word processing software is Microsoft Word and WordPerfect. Authors are encouraged to use these software packages in manuscript development to facilitate the publishing process. Authors of published articles are expected to transfer copyrights for the published material to the Natural History Society of Maryland. Prompt review of copyedited manuscripts and page proofs is the responsibility of the senior author. Reprints will be made available to the author(s) at printing costs.

Joel W. Snodgrass
Editor

Publications

The Maryland Naturalist

Back issues of *The Maryland Naturalist* are available from The Natural History Society of Maryland. Please contact our office by phone at 410-235-6116 or over the Internet at *publications@marylandnature.org* to inquire about availability. Cost per issue varies.

(1930-1960) - $3.00 per issue
(1987 to 2000) - $5.00 per issue
(2001 to present) - $10.00 per issue
Quantity discounts:
10-19 issues 15% discount
>20 issues 25% discount

Proceedings

No. 3, 1933 The Papilionidae of Maryland: A short description of the Swallowtail Butterflies of this state, with notes on the various stages of their life histories, 14 pp. by Stansbury Haydon. $2.00

No. 4, 1934 The Satyridae of Maryland: A short description of the Satyr and woodnymph butterflies of this State, with notes on the various stages of their life histories, 10 pp. by Stansbury Haydon. $2.00

No. 5, 1937 A Report on the Geology of the Patapsco State Park of Maryland, 36 pp., with map and illustration. by L. Bryant Mather, Jr. $3.50

No. 6, 1941 The Hughes Site - An aboriginal village site on the Potomac River in Montgomery County, MD, 15 pp., 5 plates. by Richard E. Stearns. $4.00

No. 9, 1943 Some Indian Village Sites of Tidewater Maryland, 31 pp., illustrations. by Richard Stearns. $2.50

No. 10, 1949 Some Indian Village Sites of the Lower Patapsco River, 6 pp., 5 plates. by Richard E. Stearns. $2.50

Mailing Information

Please include $3.00 for postage and handling for all orders up to $30.00. For orders above $30.00 please include 10% of the total order. Foreign orders add $2.00 extra to total shipping and handling. Maryland residents, please add 5% sales tax. Maryland school systems and libraries may deduct an additional 20% on publications ordered. Check or money order should accompany all orders and should be made payable to The Natural History Society of Maryland.

Please send your order to:
Publications
The Natural History Society of Maryland
2643 North Charles Street
Baltimore, MD 21218, USA

SMITHSONIAN INSTITUTION LIBRARIES
3 9088 01322 3938